



CHARACTERIZATION OF CAFO IMPACTS ON GROUND WATER FOR THE PROTECTION OF GROUND AND SURFACE WATER QUALITY

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LTG 2 Poster 07

Science Questions

MYP Science Questions

How can the sources and source strengths of stressors be inferred from in situ measurements? From stressor measurements? From biological indicators? From remotely-sensed observations and watershed properties?



Research Questions

What is the potential for CAFOs to contribute nutrients, pathogens, EDCs, and other stressors to ground water?

What is the fate of these contaminants in ground waters impacted from CAFOs, and how will they ultimately impact surface water quality?

How Research Addresses the Water Quality MYP Goals

CAFOs are primarily regulated to protect surface water quality, and the impacts of these diverse operations on ground water quality are relatively unknown. However, about 40% of the nation's average annual streamflow is from ground water, and hence it is important to preserve ground water quality to help protect surface water quality.



ORD addresses this by conducting research efforts to characterize the potential for ground water impact from a variety of stressors associated with different types of CAFOs. This includes:

- field studies to directly assess CAFO impacts
- developing analytical tools for detection of exotic stressors such as EDCs
- expanding the use of stable isotope tools for source tracking of nitrate
- working with USDA to assess the effectiveness of Comprehensive Nutrient Management Plans (CNMPs)

Research Objectives



Canton Field Site



Beaver River Field Site

The overall research objectives are to characterize the potential for ground water impact from a variety of stressors associated with different types of CAFOs, to develop tools to determine sources and specific mechanisms of impact, and to then collectively use these data to develop effective risk management strategies for protection of ground and surface water quality.

Initial Specific Research Objectives

- Evaluate three selected swine CAFO operations to understand which stressors pose the greatest risk for transport into ground water under site operating conditions

Secondary Research Objectives

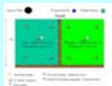
- Develop analytical tools for detection of exotic stressors such as EDCs
- Expand the use of stable isotope tools for source tracking of nitrate
- Evaluate the effectiveness of CNMPs

Long-Term Research Objectives

- Evaluate ground water impacts from other types of CAFOs
- Understand the fate of stressors in ground water and their potential for surface water impact



Cimarron Pork Field Site



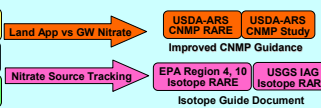
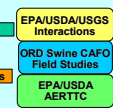
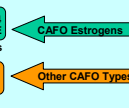
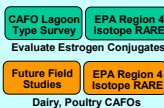
USDA-ARS CNMP Study

Research Methods & Collaboration

ORD Field Site Studies

Three commercial swine CAFO field sites were initially selected to assess ground water impacts: 1) Beaver River, 2) Canton, and 3) Cimarron Pork:

- Canton - primary site: ORD researchers established a two-year ground water monitoring program Jul 2000 - Jul 2002 for nutrients, metals, microbial indicators, and antibiotics. Subsequently, in cooperation with EPA Region 6, ORD researchers also conducted synoptic sampling of on-site wells and selected locations under the land application area in Jul 2002 for these and other parameters of interest, including natural estrogens and stable isotopes. ORD researchers continue long-term monitoring of this site to determine whether land management changes enacted in 2002, mandated by EPA Region 6 enforcement actions, will mitigate impacts to ground water and downgradient wetlands.
- Cimarron Pork - secondary site: ORD researchers are conducting long-term monitoring of contaminated ground water to ascertain the fate of nitrate, ammonia, and estrogens. In cooperation with Oklahoma Department of Agriculture, Food, and Forestry (ODAFF), ORD researchers are evaluating the performance of an organic permeable reactive barrier (PRB) for remediation of nitrate-contaminated ground water.



Collaboration/Resource Leveraging

Extensive collaboration with outside agencies/stakeholders, as well as leveraging of additional resources, are required to meet ORD's research goals:

ORD's collaborative work with EPA Region 6 led to the establishment of an ad hoc workgroup with USDA, which identified CNMPs associated with land application as an area needing additional work. This led to:

- an Inter-Agency Agreement (IAG) USDA so that USDA researchers can conduct a comprehensive assessment of a CNMP for transport of nutrients and pathogens through the root zone during land application of dairy waste
- An IAG with other USDA researchers to monitor nutrient transport on a much simpler scale for additional CAFOs using separate EPA Region 6 Regional Applied Research Effort (RARE) funds

ORD researchers also concluded that using the stable isotope of nitrate can provide effective nitrate source tracking in some instances, but that much more work is needed to make this more applicable. This led to:

- Collaboration with EPA Regions 4 and 10 personnel on nitrate source tracking using multiple isotopes (again supported in part by RARE funds)
- An IAG with the USGS to conduct multiple isotope analyses on the EPA Region 4 project and to then develop a practical guide document

Research Results

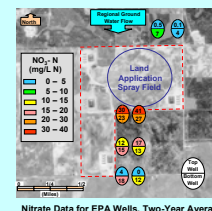
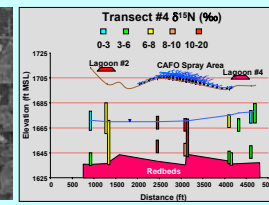
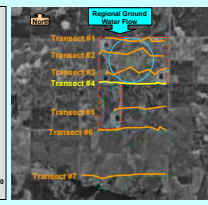
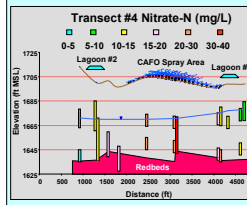
Canton Field Site Findings

- Nitrate is the predominant ground water stressor
- Isotopic data confirm ground water contamination by nitrate from land application activities
- Antibiotics detected in lagoons, but rarely in ground water
- Estrogens detected in lagoons, but rarely (once) in ground water

A ground water flow model has been developed for the site. Initial time of travel results from calibrated model using particle tracking indicate that ground water at the southern edge of the spray field reaches the irrigation wells and wetland in seven and twenty years, respectively.

Canton Field Site Findings Lead to Additional Questions:

- Is this field site representative of other swine CAFO operations?
- What can be expected from other types of CAFOs?
- Are CNMPs truly protective of ground water?
- Can multiple stable isotope analyses provide more definitive source tracking of ground water nitrate?

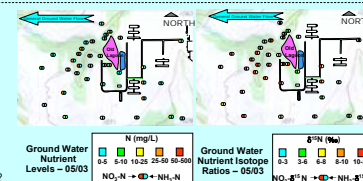


Cimarron Pork Field Site Findings

- Extensive ground water contamination by nitrate and ammonia from old leaking lagoon
- Isotopic data confirm ground water contamination by ammonia and nitrate from animal sources
- Antibiotics not detected in ground water
- Estrogens detected in ground water adjacent to lagoon
- Site remediation activities are decreasing ground water nutrient levels; surface water nutrient levels are also declining

Cimarron Pork Field Site Findings Lead to Additional Questions:

- What is long-term fate of estrogens in ground water?
- How effective will the organic PRB be in ground water remediation?
- How will ground water remediation ultimately impact surface water quality?



Research Conclusions & Future Directions

Research Conclusions

- Swine CAFOs can contaminate ground water with nutrients and estrogens

Subsequent Hypotheses

- These data may be representative for other types of CAFOs
- CNMPs for land application practices may be inadequate
- Surface water systems could become negatively impacted
- Nitrate source tracking methods can be optimized



Monitoring Land Application

Future Directions

- Continue to monitor ground water quality at these sites to assess long-term impact on ground and surface water
- Evaluate additional types of CAFOs to more completely determine the potential for ground water impact
- Focus near-term research efforts on CNMP effectiveness and nitrate source tracking
- Develop long-term research objectives based on continued collaborations with USDA and other agencies

Interactions with Customers

Principal customers for this research include EPA Regions, EPA Office of Water, and State Agencies.

- ORD provided EPA Region 6 with extensive data at the Canton field site, some of which were used by EPA Region 6 to issue enforcement actions
- ORD researchers have been collaborating with EPA Region 6 personnel to assess whether enforcement actions will mitigate ground water impacts
- ORD provides technical support to ODAFF in monitoring of PRB performance at Cimarron Pork
- ORD provided technical support to EPA Office of Water in evaluating proposals submitted for consideration of funding
- ORD provided technical support to USDA-ARS by participating in National Program Review on USDA-ARS 206 CAFO Manure Program



Effective technology transfer is required so that research efforts can be targeted to those science questions posing the greatest immediate need.

- ORD researchers serve as co-chairs on two workgroups established within the EPA/USDA AFO Environmental Research and Technology Transfer Committee (AERTTC):
 - Land Application (E. Striz)
 - Chemical Source Tracking (S. Hutchins)

How Research Contributes to Outcomes

- EPA's Office of Water, the States, and others are expected to use ORD's research to guide implementation of the CAFO Rule
 - EPA Regions in particular are expected to use isotope source tracking methods to identify sources of nitrate contamination of ground water in enforcement investigations
 - USDA-NRCS is expected to issue new guidelines on CNMPs to be more protective of ground water
- The result will be more cost-effective protection of ground water, leading to reduced risks to human health and aquatic ecosystems.